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5 soon passed and the rest of the month was rather even weather, with not a low temperature. . On March 25 I found that Piping Plovers had arrived on the beach, but I saw neither Sanderlings nor Red-backs.

April 1 was warm, sunny and springlike. "Many Geese are going over the beach and I find that the numbers of Piping Plovers have increased since March 25. Saw two Sanderlings which may or may not have been the birds of last winter."

52 Cedar St., Malden, Mass.

SEQUESTRATION NOTES.

BY JOSEPH GRINNELL.¹

THERE is every reason to believe that the voices of birds have been subject to a process of evolution which has led from the simplest beginnings to a condition which is rather complicated in the higher present-day species. The first sounds uttered by primitive birds were doubtless entirely of an incidental nature, due to expulsion of air under stress of pain or fear, or simply of physical impact. According to one theory (Witchell, 'The Evolution of Bird-Song,' London, 1896) the first specialization accompanied combat and involved a meaning of defiance or intimidation; from this it was an easy step to notes conveying the idea of alarm to other individuals of the same species.

Whatever the course in the early development of bird voices, it is obvious to any field student that in the higher existing birds an often very elaborate system of cries or calls obtains, with an associated wide range of meaning; as witness the Titmouses and Ruby-crowned Kinglets. Some of the meanings, in certain species, have been demonstrated beyond all question of doubt. The less obvious meanings will have to be worked out by slow process, and exceeding care be taken to avoid mere guess-work.

¹ Contribution from the Museum of Vertebrate Zoölogy of the University of California.

A seemingly adequate method of deciding upon the meaning of bird voices is to note as accurately as possible (1) the exact nature of the sounds produced in all particulars, and at the same time (2) the behavior of the bird when uttering each kind of note, and (3) the conditions obtaining with respect to all extraneous factors such as relate to activities of other individual birds in the vicinity, other animals, cover, and forage. The degree of reliance upon the inferences from such observations will increase with the number of times these observations are repeated. The final and satisfactory explanation will not be forthcoming at once, though it is well to hold whatever meaning presents itself even from the outset as a tentative hypothesis.

Some years ago the attention of the present writer became directed to the behavior and notes of certain non-flocking passerine birds as exhibited during the winter season. Dearth of other ornithological features of interest at that season was probably the circumstance which favored the development of the following ideas. The particular class of notes here to be considered are those of the category commonly called "location" or simply "call" notes, and are uttered at irregular intervals by certain birds when foraging singly under normal conditions.

To be more explicit, the birds in the writer's experience especially concerned are the Ruby-crowned Kinglet (*Regulus calendula*) and Audubon's Warbler (*Dendroica auduboni*). The common winter call-note of the former is the familiar rachety, tone-less noise, of three or more sections or syllables. The usual call-note of the latter is the rather sharp single syllable, *tsip*. The notable thing with both species is that their notes are uttered at rather frequent intervals, though irregular ones, by each individual as it forages *alone*. There are often to be heard in the distance, many trees away perhaps, other individuals of the same species; but a point of importance here is the essentially non-flocking habit in both the species under consideration.

I am aware that Ruby-crowned Kinglets do occasionally assemble to a limited extent in winter; for example when "mobbing" an owl. Or, late in the afternoon, as many as five or six individuals may be found in the same tree on a sunny upper hill-slope, especially if the trees be scattering. Also, Audubon's Warblers sometimes collect

in numbers up to a dozen or more in one tree, such as a blossoming eucalyptus, or in a clump of fruiting *Rhus laurina*. But the individuals in all such gatherings show themselves to be thoroughly independent of one another; each goes his own way; and there is, indeed, frequent evidence of friction or conflict of individual interests. There is no indication of coördination of movement, as with truly flocking birds: no individual advantage is gained by the gathering.

Observation of any one Ruby-crowned Kinglet under the usual winter-day conditions in southern or west-central California, shows it to be almost continually intent upon its search for insects. Its mode of search, and the category of insects which its equipment fits it to make use of, direct its forage course as a rule through thick leafy terminal foliage of evergreen trees and shrubs, less generally, perhaps, among the stems of willows and alders, where, however, there are usually left-over, curled-up leaves, and plenty of crannies behind buds and in clefts of forking twigs, to harbor small insects. But insects are relatively scarce in winter, increasingly so as the season advances; and the Kinglet's scrutiny must be rapid. Each individual Kinglet *must cover much territory in limited time* in order to gather the food in sufficient quantity.

As it thus forages, each Kinglet every now and then utters its note, or series of notes. Another individual, or others, may be heard from time to time in the distance, but I have failed altogether to receive the impression that two or more birds "answer one another." My experience is that they most certainly do *not* come *towards* one another as the result of such calls. And here the idea presents itself, logically, that these notes serve to keep the foraging birds *apart*: they are *sequestration notes*.

The nature of the conditions which call forth this category of notes, which makes them of *use* in the struggle for existence on the part of the species, would seem to me to be as follows. The Kinglet is a foliage forager and is most of the time within or in close reach of adequate cover; hence for the most part it is safe from both aerial and terrestrial predators. It relies for food upon small insects, mainly stationary, which in the winter season are not abundant, sometimes exceedingly scarce, as shown by occasional periods when some of the birds starve; the Kinglet cannot dig after its

insects or uncover them, but must look for them in plain sight; it must scrutinize a large area of leaf and twig to find enough, and it must *avoid duplicating territory that its neighbor Kinglet has scrutinized*. In other words it is of critical need that the individuals of a species whose food is of this nature, and must be gotten in this way, be continually *spaced out* over the available food producing territory. Two or more individuals must not follow each other's paths or look over the same ground, at least until there has been time for insect life to move about again.

With Audubon's Warbler the conditions are very much the same as with the Ruby-crowned Kinglet, save that the forage beat of the former lies, as a rule, in more open trees and bushes, or on the outer surfaces of masses of foliage. The *tsip*-notes are uttered seemingly for the same general purpose, to keep neighboring individuals from duplicating territory. With both the Warblers and the Kinglets, it is not uncommon in winter to see two individuals, which may happen to encounter one another in the same tree, assume a hostile manner of behavior and tone of voice. The latter consists in each case, of the same sort of expression as the sequestration note, but uttered with more emphasis. In the case of male Kinglets, there are flashes from the unfurled coronal, and one of the birds quickly puts the other to flight; each is soon pursuing separate forage routes in different directions.

In the case of the Audubon's Warblers, again, it is quite true that two or more individuals often enter into loose membership in the roving aggregations of birds which travel about the open country in winter and include in their number, bluebirds, certain sparrows and even pipits. And also one often encounters a number of Audubon's Warblers, not in company of other birds, trailing along in the same general direction, with indications that they are trying to keep in loose contact with one another. And here it is possible a shade of meaning in their voices invites collectivity. Indeed one can conceive of a note being both centrifugal and centripetal in meaning, the latter to a given radius, the former beyond. But now our discussion has departed into the realm of speculation.

In thus assigning the function of sequestration to certain notes of certain birds, the writer has placed confidence in an accumulation of impressions received during a number of years of observation.

The species concerned are among our commonest everyday winter birds. Verification of this explanation, or the refutation of it, should be easy to secure on the part of persons who are interested in the natural history of living birds; for there are many such nowadays, in excellent position to make accurate observations, and to make from these valid inductions.

Museum Vert. Zool., Berkeley, Calif.

ON *PROCELLARIA ALBA* GMELIN.

BY LEVERETT MILLS LOOMIS.

THE technical name *Procellaria alba* has long been a stumbling-block in the way of nomenclators. It was proposed by Gmelin in 1789 in Volume I, Part II (p. 565) of his edition of Linnæus's 'Systema Naturæ.' The following is Gmelin's description:

"Fr. ex fusco nigra, gulæ area, pectore, abdomine et crisso albis, rectricibus [tectricibus] caudæ inferioribus ex cinereo et albo mistis.

White-breasted Petrel. *Lath. Syn.* III. 2. p. 400. n. 6.

Habitat in insulis Turturum et nativitatis Christi, 16, pollices longa.

Rostrum nigrum; cauda rotundata; pedes ex atro fuscis; digitis anteriore dimidia sui parte cum membrana connectente nigri."

From the above, it is apparent that Gmelin based his *Procellaria alba* upon Latham's White-breasted Petrel, the description of which reads as follows:

"LENGTH sixteen inches. Bill an inch and a half long, hooked at the tip, and black: the head, neck, and upper parts of the body, dusky brown, nearly black: on the throat a whitish patch: breast, belly, and vent, white: under tail coverts cinereous and white mixed: tail rounded at the end: legs black brown: the fore part of the toes half way black; the outside of the exterior toe the same for the whole length: webs black: spur behind blunt.

Inhabits *Turtle* and *Christmas Islands*. In the collection of Sir *Joseph Banks*."¹

¹ General Synopsis of Birds, Vol. III, Pt. 2, 1785, p. 400.